鹿児島県立短期大学紀要　第64号　2013年12月26日発行

人文・社会科学篇　抜刷

A Preliminary Study of the Applicability of Neurolinguistic vs. Evolutionary Linguistic Factors to Second Language Acquisition (1)

久木田　美枝子

KUKITA　Mieko

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Mieko KUKITA

Key Words: SLA, Neurolinguistics, Evolutionary

1. Introduction

This paper is a preparatory step in investigating the applicability of the viewpoints of neurolinguistic theory and the evolutionary linguistic approach to second language acquisition. Concerning the neurolinguistic theory, most current research focuses on event-related brain potentials (ERPs) and functional magnetic resonance imaging (fMRI) etc. in syntactic processing data.[1]

In the previous approach to language acquisition, the innate or unconscious knowledge of language in the brain could not be measured exactly. Concerning the process of language acquisition, in particular the concept of critical period or sensitive period might have the need to be modified as a result of exact neurolinguistic findings. In addition to this, current findings in neurolinguistics might show how to improve already existent teaching methods and techniques, leading to more effective instruction.

Counter to this, the concept of evolutionary linguistics has been discussed recently. The starting point of evolutionary linguistics seems to be based upon the hypothesis suggested by Noam Chomsky with other ethologists, Marc D. Hauser and W. Tecumseh, even though discussions about language origin and evolution were banned in the past, when scientific concepts about genes and

[1] Sonja A. Kotz (May- June 2009) "A critical review of ERP and fMRI evidence on L2 syntactic processing," *Brain and Language* Vol. 109, Issues 2-3, 68-74, Elsevier,Amsterdam.

neurons were not established. However, with current biological discoveries, research suggests a clear distinction between the faculty of language in the broad sense (FLB) and in the narrow sense (FLN).[2] Eevolutionary linguistics appears to be the most current approach in linguistics. However, the applicability of the evolutionary aspect has never been taken up. With the application of the evolutionary aspect, the learning process might be clarified with the concept of UG.

In Section 2, the current approach to neurolinguistics will be described based on a paper by Andrea Moro. In Section 3, the current approach to evolutionary linguistics will be shown based on the theory suggested by Noam Chomsky and Ray Jackendoff. The applicable aspects both in neurolinguistics and evolutionary linguistics will be considered.

2. Previous Concept of the Neurolinguistic Method

2.1. Chomsky's basic concept

Based upon the traditional concept suggested by N.Chomsky, the computational activities in the brain seem to involve the concept of I-language, which he describes as "some element of the mind of the person who knows the language, acquired by the learner, and used by the speaker."[3] Traditionally, the concept of I-language can be referred to in comparison with the concept of E-language within the philosophical viewpoints of language. In addition, within

[2] Marc.C. Hauser, Noam Chomsky, W.Tecumseh Fitch (2002) "The Faculty of Language: What Is It, Who Has It, and How Did It Evolve?" *Science* Vol. 298, Issue 5598, 1569-1579, *Science* AAAS, New York.

[3] Noam Chomsky (1986) *Knowledge of Language: its Nature, Origin and Use*, 22, Praeger, New York

the Minimalist program theory, it is interesting to notice that he mentioned the ERP study as a new horizon, as follows:[4]

> Like other complex systems, the brain can be studied at various levels: atoms, cells, cell assemblies, neural networks, computational-representational (C-R) systems, etc. The ERP study relates two such levels: electrical activity of the brain and C-R systems…
>
> In the case of language, the C-R theories have much stronger empirical support than anything available than other levels, and far superior in explanatory power; they fall within the natural sciences to an extent that inquiry into "language speaking" at the other levels does not. In fact, the current significance of the ERP studies lies primarily in their correlations with the much richer and better-grounded C-R theories. Within the latter, the five categories have a place and, accordingly, a wide range of indirect empirical support; in isolation from C-R theories, the ERP observations are just curiosities, lacking a theoretical matrix…

As shown above, Chomsky seemed to suggest that, with the steady development of diagnostic medical equipment, the ideal methods of language acquisition in the brain will be neurophysiological methods. However, his claim appears to involve various suggestions in interdisciplinary research. In particular, he has demonstrated a lot of curiosity in ERP observations, but he claims that the observations of ERP are lacking theoretical matrix. On this point, his basic attitude appears to focus on ERP observations. Presumably,

[4] Noam. Chomsky (2000) *New Horizons in the Study of Language and Mind*, 24-26, Cambridge University Press, Cambridge.

he is eager to claim that every observation has to be demonstrated with the theoretical background. The ERP observations alone are not sufficient to explain the competence in the brain.

2.2. Andrea Moro's experiment

It is interesting to notice the concept suggested by Andrea Moro,[5] focused on the results of the experimental methodology of fMRI neuroimaging. By means of his experiment, Moro has proved that the principle of structure dependency is valid, namely, that no syntactic rule can refer to the linear order of words. The new concept derived from neuroimaging seems to apply to second language acquisition in the same way as first language acquisition.

The methods of the experiment involve complicated procedures. The examinees are native speakers of German, with information given in Italian and Japanese. The particulars for his experiment involve the following rules:[6]

Possible and Impossible Rules in Italian and Japanese

Ⅰ　*Possible rules in Italian*

1. Subject omission
2. Verb position in passive sentences
3. Verb position in embedded clauses

Ⅱ　*Impossible rules in Italian*

1. Fixed position of negation in the sentence as the fourth word
2. Interrogative sentences invert the word order of declarative sentence

[5] Andrea Moro (2008) *The Boundaries of Babel*, 121-178, MIT Press, Cambridge.
[6] *Ibid*., 170.

3. The first indefinite article agrees with the last noun

Ⅲ *Possible rules in Japanese*

1. Word order in the main clause

2. Word order in passive sentences

3. Embedded clauses

Ⅳ *Impossible rules in Japanese*

1. Fixed position of negation in the sentence as the fourth word

2. Interrogative sentences invert the word order of declarative sentences

3. Past is formed by adding a suffix to the fourth word

The experiment was actually performed as follows. First, subjects were taught a minimal vocabulary of one language or the other in order to exclude lexical learning from our learning task. For Italian, we taught thirty-three nouns, articles, and six first-conjunction verbs with their helping verbs. For Japanese, we taught twenty-one nouns and four verbs. Subjects were not given any information about the phonology of the words (essentially, they read them with their own German accent). Before we started the learning tasks, we verified that the subjects had actually learned their vocabulary. Once the experiment started, they had to push a button with a finger of the left hand after deciding whether the sentence followed the given rule or not. They were taught a new rule after a three-minute pause between sessions. Stimuli were presented on a screen for thirty seconds while subjects were lying on the fMRI table. The first image described the rule with some examples and each of the following images showed one sentence. Subjects had to judge the grammaticality of each subject on the basis of the rule they had

> just learned. Preliminarily, the experiment was performed on twenty other subjects without fMRI measures to verify the effectiveness of the learning and judging process.

Based upon the experiment mentioned above, Moro measured the reaction time and accuracy in judging the grammaticality of the sentence, and found that the percentage of subjects' correct answers were identical for both possible and impossible rules in both languages, concluding as follows:[7]

> Following or violating structure dependence is, therefore, irrelevant when it comes to learning accuracy: subjects reached the same level of mastery with both possible and impossible rules…

Concerning the executive part of the experiment with fMRI, the results were as follows:

> The graphs show that, when subjects are judging the grammaticality of Italian sentences, the more accurate the answers are the more Broca's area is activated with possible rules and the less it is activated with impossible rules.

Moro has proved that the principle of structure dependency in the brain is valid, which seems to show that structural hierarchy may be innate or closely related with UG in natural language. Furthermore, Moro mentions, as follows:[8]

[7] *Ibid*., 171.

[8] *Ibid*., 175.

> The brain has "sorted out" the syntactic data, without the subjects' realizing it: Broca's area, which is included in the network that is naturally predisposed for syntactic tasks, has been progressively activated when processing rules that respected structure dependency while it has been progressively deactivated when processing sentences that did not.

As the hypothesis indicates, it appears to be plausible to acquire structural hierarchy unconsciously in the brain when learning a second language . Such a neurolinguistic evidence can be effective in formulating some plausible methods for second language acquisition. Without recognizing it, humans can acquire the rule, structural dependency.

Such neurolinguistic achievements seem to induce the following evolutionary aspect, with the basic concept "recursiveness" and "Merge." Only the structural hierarchy exists in the brain, closely related to UG.

3. Current Concept of Evolutionary Linguistic Approach

The concept of evolutionary linguistics has been much discussed recently. The starting point of evolutionary linguistics seems to be based upon the hypothesis suggested by Noam Chomsky, along with other ethologists, Marc D. Hauser and W. Tecumseh. However, with current biological discoveries, they submit a clear distinction between the faculty of language in the broad sense (FLB) and in the narrow sense (FLN). The definition is as follows:[9]

> We suggest how current developments in linguistics can be profitably

[9] *Opcit.*, 1569.

> wedded to work in evolutionary biology, anthropology, and neuroscience. We submit that a distinction should be made between the faculty of language in the broad sense (FLB) and in the narrow sense (FLN). FLB includes a sensory-motor system, a conceptual-intentional system, and the computational mechanisms for recursion, providing the capacity to generate an infinite range of expressions from a finite set of elements. We hypothesize that FLN only includes recursion and is the only uniquely human component of the faculty of language.

Furthermore, Chomsky has referred to UG in relation to evolutionary linguistics, as follows:[10]

> Evidently, growth of language in the individual ("language learning") must involve the three factors that enter into development of organic systems more generally: (i) genetic endowment, which sets limits on the languages attained; (ii) external data, which select one or another language within a narrow range; (iii) principles not specific to the language faculty. The theory of the genetic endowment is commonly called "universal grammar" (UG), adapting a traditional term to a new context. The study of evolution of language is specifically concerned with UG and its origins…

[10] Noam Chomsky (2010) "Some Simple Evo Devo Theses: How True Might They Be For Language," In R.K.Larson, V.Deprez, and H. Yamakido (eds.) *The Evolution of Human Language: Biolinguistics Perspectives*, 45-62, Cambridge University Press, Cambridge.

As mentioned above, concerning the studies of evolutionary linguistics, UG can play a very important role. To clarify the peculiarity of UG might lead to an examination of the evolutionary aspect of language. Furthermore, Chomsky suggests the thesis called "the strong minimalist thesis" (SMT), as follows:[11]

> Taking T – or better, if possible, SMT – as a guideline, the basic tasks are to account for: (i) recursion – optimally just Merge; (ii) the lexical/conceptual items that are the "atoms" of computation; (iii) the properties of the SM and C-I interfaces insofar as they fall within UG/FLN; (iv) the interpretive mechanisms that map syntactic objects into a form interpretable at C-I (with many fundamental open questions about where operations apply in the overarching cognitive system); the secondary process of externalization, insofar as it is shaped by UG constraints; (vi) whatever resists principled explanation in the sense outlined earlier.

In addition to this, Ray Jackendoff suggests the inferential relation between theory of linguistic knowledge and evolutionary theory:[12] The explanation of UG seems to be essential to seek the evolutionary aspect. Indeed, neurolinguistic aspects have shown the activated instantaneous movement in the brain, which has proved that the structural hierarchy can be recognized in the brain. This concept can play a very important role in studying the principled aspect in the brain. However, evolutionary linguistics tends to seek the learning process as well as the origin of language. This concept will be valuable

[11] *Ibid.*, 62.

[12] Ray Jackendoff (2010) "Your Theory of Language Evolution Depends on Your Theory of Language," In R.K. Larson et al. (eds.), *The Evolution of Human Language: Biolinguistic Perspectives*, 63-72, Cambridge University Press, Cambridge.

in seeking a plausible method in learning, SLA.

In addition, based on the evolutionary aspect, the following tentative scheme will be considered in SLA.

Precursor → UG → Interface + Merge → Language

4. Closing Remarks

As indicated in the introduction, this paper is a preparatory step to carrying out research on the most suitable method in SLA, by comparing neurolinguistic theory to the evolutionary aspect. With the further development of linguistic theories, the best method of learning will need to be thoughtfully deliberated.

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